Imperial Solar Energy Center South

Appendix H2

Preliminary Water Quality Report

Prepared by Tory R. Walker Engineering, Inc.

October 4, 2010

PRELIMINARY WATER QUALITY REPORT

For

Imperial Valley South Solar Farm

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TABLE OF CONTENTS

ATTACHMENTS

LIST OF TABLES AND FIGURES

1.0 INTRODUCTION

The purpose of this Water Quality Report is to address water quality impacts from the proposed Imperial Valley South Solar Farm project. Site design, source control, and treatment control Best Management Practices (BMPs) will be utilized to provide long term solutions to protect storm water quality. This report is subject to revisions as needed to accommodate changes to the project design, or as required by the County and/or Engineer.

1.1 Project Location

The project site is located in Imperial County between Mt. Signal Road and Pulliam Road and south of Highway 98. Figure 1.1 (below) illustrates the project location.

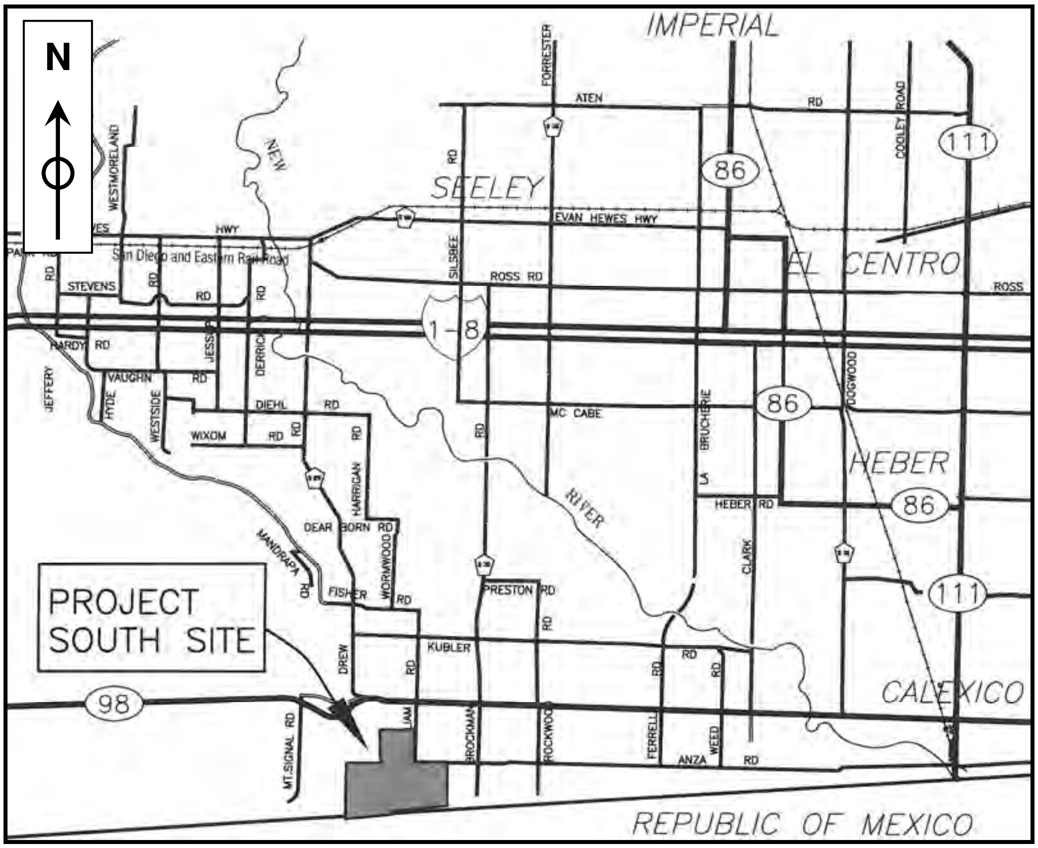

Figure 1.1 Vicinity Map (No Scale)

1.2 Project Description

This project will construct a photovoltaic Solar Energy Farm and will utilize the area bordered by Mt. Signal road to the west, Pulliam Road to the east, the US/Mexico Border to the south, and just south of Highway 98 to the North. Existing runoff flows generally south to north and the majority of the existing drainage pattern will be unchanged. Details can be found in the drainage report titled "Preliminary CEQA Level Drainage Study for Imperial Valley South Solar Farm" dated 4 October 2010 prepared by Tory R. Walker Engineering, Inc.

1.3 Project Size

The project area is approximately 838 acres.

1.4 Impervious and Pervious Surface areas

The existing project area is currently crop fields, approximately 0% impervious, and will increase just over ½ percent to 0.6% impervious with the proposed construction. The project includes approximately 118 concrete slab pads for the inverter units, a 5,000 ft^2 operations and maintenance building with associated parking lot of approximately 6,850 ft^2, a 5,000 ft^2 water treatment building, and solar panels supported on posts (making a negligible impervious footprint). The project will utilize a gravel surface for the service roads.

2.0 PROJECT SITE ASSESSMENT

This section includes information used to consider the potential water quality and hydrologic impacts from the proposed project. This information is important when considering the appropriate BMPs to reduce identified potential impacts as well as designing source control and treatment control measures to reduce those impacts.

2.1 Land Use and Zoning

Historic Land Use is cropland.

2.2 Existing Topography

The project site area is generally flat, sloping gently from south to north, with elevations ranging from 12 feet above sea level to 9 feet below sea level.

2.3 Existing and Proposed Drainage

In the existing condition, runoff generally flows from south to north. Proposed condition drainage patterns will be similar, with runoff flowing from south to north. Runoff from significant areas of the site in the proposed condition will sheet flow across the site as in the existing condition and be collected by ditches and culverts and routed to the Imperial Irrigation District (IID) drain system. There is an existing onsite system comprised of perforated tile drains that may convey flows to the IID drain system. These drains include the Mt. Signal Drain #3 and 4, the Carpenter Drain #1, and the Greeson Drain. Detention will be provided on the site so that the proposed drainage replicates the existing condition. Details can be found in the drainage report titled "Preliminary CEQA Level Drainage Study for Imperial Valley South Solar Farm" dated 4 October 2010 prepared by Tory R. Walker Engineering, Inc.

2.4 Watershed, Receiving Waters, and Beneficial Uses

The proposed project is located within the Imperial Hydrologic Unit, Brawley Hydrologic Area, and an undefined Hydrologic Sub-area (Basin Number 723.10). The surface and groundwater receiving waters located in the area and downstream of this project include the Mt. Signal Drain #3 and 4, the Carpenter Drain #1, the Greeson Drain, the New River, and the Salton Sea.

From Table 2-3 of the Water Quality Control Plan for the Colorado River Basin Region the Beneficial Uses of the area west of the Mt. Signal Drain #3 and 4 and the Carpenter Drain #1 (all considered part of the IID drains), the Greeson Drain, the New River, and the Salton Sea are as follows:

Table 1

Ground Waters	Hydrologic Unit Basin Number	MUN	AGR	IND	PROC	GWR	FRESH	POW	REC1	REC2	BIOL	WARM	COLD	WILD	RARE	SPWN	AQUA
Imperial Valley Drains	723.10						X		X	X		X		X	X		
New River	723.10			X			X		X	X		X		X	X		
Salton Sea	728.00			X					X	X		X		X	X		X

2.5 303(d) Listed Receiving Waters

The impaired waterbodies listed on the 303(d) list for this Hydrologic Area (728) are the Imperial Valley Drains, the New River and the Salton Sea. This project does not flow to a drain included on the 303(d) listing of Imperial Valley Drains so no drain listings are provided in this section. The New River is listed for 1,2,4-Trimethylbenzene, Chlordane, Chloroform, Chlorpyrifos, Copper, DDT, Diazinon, Dieldrin, Mercury, meta-par xlyenes, Nutrients, Organic Enrichment/Low Dissolved Oxygen, o-Xylenes, PCBs, p-Cymene, p-Dichlorobenzene/DCB, Pesticides, Selenium, Toluene, Toxaphene, Toxicity, and Trash. The Salton Sea is listed for Nutrients, Salinity, and Selenium.

The project is approximately: less than 100 yards to the Mt. Signal Drain #3 and 4, less than 100 yards to the Carpenter Drain #1, 3 miles to the Greeson Drain, 7 miles to the New River, and 52 miles to the Salton Sea.

2.6 Total Maximum Daily Loads (TMDLs)

Table 2

Receiving Water	Hydrologic Unit Basin Number	TMDL	Distance From Project (miles)
Imperial Valley Drain (Mt. Signal Drain #3 and 4, the Carpenter Drain #1, and the Greeson Drain)	723.10	Sedimentation./Siltation	~100 yards
New River	723.10	Pathogens Sedimentation./Siltation Trash	~ 7

2.7 Soil Type(s) and Conditions

Soil types are classified as hydrologic soil groups A through C. Existing vegetation is agricultural cropland.

3.0 POLLUTANTS OF CONCERN

This section identifies pollutants of concern.

3.1 Project Categories and Features

The project includes concrete slab pads for the inverter units, an operations and maintenance building with associated parking lot and a water treatment building, and solar panels supported on posts (making a negligible impervious footprint). The project will utilize pervious gravel surfaces for the service roads. Project will include a septic system for sanitary sewage disposal.

3.2 Pollutants of Concern

Downstream waters are listed for the following pollutants of concern which are also potential pollutants from this project:

<u>3.2 (a) – Sediments</u>

Soils or other surface materials eroded and then transported or deposited by the action of wind, water, ice, or gravity. Sediments can increase turbidity, clog fish gills, reduce spawning habitat, smother bottom dwelling organisms, and suppress aquatic vegetative growth.

<u>3. 2 (b) – Heavy Metals</u>

Metals are raw material components in non-metal products such as fuels, adhesives, paints, and other coatings. Primary sources of metal pollution in storm water are typically commercially available metals and metal products. Metals of concern include cadmium, chromium, copper, lead, mercury, and zinc. Lead and chromium have been used as corrosion inhibitors in primer coatings and cooling tower systems. Metals occur naturally at low concentrations in soil, and are not toxic at these concentrations. However, at higher concentrations, certain metals can be toxic to aquatic life. Humans can be impacted from contaminated groundwater resources and bioaccumulation of metals in fish and shellfish. Environmental concerns, regarding the potential for release of metals to the environment, have already led to restricted metal usage in certain applications.

<u>3. 2 (c) – Trash & Debris</u>

Examples include paper, plastic, leaves, grass cuttings, and food waste, which may have a significant impact on the recreational value of a water body and aquatic habitat. Excess organic matter can create a high biochemical oxygen demand in a stream and thereby lower its water quality. In areas where stagnant water is present, the presence of excess organic matter can promote septic conditions resulting in the growth of undesirable organisms and the release of odorous and hazardous compounds such as hydrogen sulfide.

<u>3. 2 (d)– Oil & Grease</u>

Characterized as high high-molecular weight organic compounds. Primary sources of oil and grease are petroleum hydrocarbon products, motor products from leaking vehicles, oils, waxes, and high-molecular weight fatty acids. Elevated oil and grease content can decrease the aesthetic value of the water body, as well as the water quality.

<u>3. 2 (e)– Pesticides</u>

Chemical compounds commonly used to control nuisance growth or prevalence of organisms and includes herbicides. Excessive application of a pesticide may result in runoff containing toxic levels of its active component.

3.3 Project Water Quality Analyses

Tributary flows from over 838 acres will be attenuated onsite, replicating the pre-project condition. Runoff will be detained in under-panel and designated detention basins.

4.0 BEST MANAGEMENT PRACTICES (BMPs)

Site Design, Source Control, and Treatment Control BMPs will be utilized and are described in the following sections.

4.1 Site Design Strategies and BMPs

Conceptually, there are three strategies for managing runoff from buildings and paving:

1. Optimize the site layout;
2. Use pervious surfaces;
3. Disperse runoff.

This section describes how Site Design strategies have been implemented in the proposed project design.

4.1.1 Optimize the Site Layout

The very nature of the proposed land use optimizes the site layout thus limiting the development envelope. The existing drainage patterns will be maintained.

4.1.2 Use Pervious Surfaces

Service roads will use a pervious gravel surface.

4.1.3 Disperse Runoff

The pervious surfaces will drain to detention areas within the project site.

4.2 Source Control BMPs

It is possible that the following pollutants could be generated at this site: Sediment, Heavy Metals, Trash & Debris, Oil & Grease, and Pesticides.

Based on these anticipated pollutants and operational activities at the site the Source Control BMPs to be installed and/or implemented onsite are summarized below:

- Trash storage
- Integrated Pest Management
- Efficient irrigation and landscape design
- Property owner educational materials regarding source control management

4.3 Treatment Control BMPs

Structural Treatment (treatment control) BMPs are engineered, designed, and constructed to remove pollutants from urban runoff by simple gravity settling of particulate pollutants, filtration, biological uptake, media absorption, or any other physical, biological, or chemical process.

This section discusses the basis for selection and details of the proposed structural treatment BMPs being utilized on this project, as well as methodology used to determine the peak rate of runoff to be treated. Also discussed are targeted pollutants and pollutant removal efficiency information.

The Preliminary CEQA Level Drainage Study for Imperial Valley West Solar Farm" dated 4 October 2010 prepared by Tory R. Walker Engineering, Inc. is the basis for design of the structural treatment BMPs. The SCS Method was used to determine the flows for the existing and proposed conditions. Rainfall data was determined from the NOAA 14 Atlas.

The structural treatment BMPs and drainage facilities can be seen on Figure 2, Site Map (BMP Location Map) located in Attachment 2. Extended Detention Basins were sized for the major subareas and the Operations and Maintenance Facility. Under-panel detention will also be utilized on the eastern portion of the site.

Typical pollutant removal efficiencies of treatment control BMPs are shown in Table 3 below. The column entitled, "Detention Basins" is shaded to reflect the treatment BMP proposed for the site.

Table 3

Pollutant of Concern	***Treatment Control BMP Categories***						
	Biofilters	Detention Basins	Infiltration Basins(2)	Wet Ponds or Wetlands	Drainage Inserts	Filtration(4)	Hydrodynamic Separator Systems(3)
Sediment	M	H	H	H	L	H	M-H
Nutrients	L	M	M	M	L	M-H	L-M
Heavy Metals	M	M	M	H	L	H	L-M
Organic Compounds	U	U	U	U	L	M-H	L-M
Trash & Debris	L	H	U	U	M	H	M-H
Oxygen Demanding Substances	L	M	M	M	L	M-H	L
Bacteria	U	U	H	U	L	M	L
Oil & Grease	M	M	U	U	L	H	L-H
Pesticides	U	U	U	U	L	L-H	L

(1) Copermittees are encouraged to periodically assess the performance characteristics of many of these BMPs to update this table.
(2) Including trenches and porous pavement.
(3) Also known as hydrodynamic devices.
(4) For Proprietary Structural BMPs, not all serve the same function or have the same efficiency.

L (Low): Low removal efficiency (roughly 0-25%)
M (Medium): Medium removal efficiency (roughly 25-75%)
H (High): High removal efficiency (roughly 75-100%)
U: Unknown removal efficiency, applicant must provide evidence supporting use

Sources: *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (1993), *National Stormwater Best Management Practices Database* (2001), and *Guide for BMP Selection in Urban Developed Areas* (2001).

4.3.1 Detention Basins

Detention basins are passive systems whose outlets have been designed to detain the stormwater runoff from a water quality design storm for some minimum time to allow particles and associated pollutants to settle. They can also be used to provide flood control by including additional flood detention storage. They have high removal effectiveness for trash and medium effectiveness for Sediment, nutrients, metals, bacteria, oil and grease, and organics. This project is anticipated to generate sediment similar to the pre-developed condition. It has the potential to generate trash.

5.0 PROJECT PLAN(s) & BMP LOCATION MAP

BMP Location Map is provided in Attachment 2.

6.0 BMP MAINTENANCE

Proper maintenance is required to insure optimum performance of the Detention Basins. Maintenance will be the responsibility of the owner throughout the life of the project. Owner will also instruct any future owner of the maintenance responsibility. The operational and maintenance needs of the proposed detention basins and under-panel detention basins include:

- Periodic sediment removal.
- Monitoring of the basin to ensure it is completely and properly drained.
- Outlet structure cleaning.
- Vegetation management.
- Removal of weeds, tree pruning, leaves, litter, and debris.
- Vegetative stabilization of eroding banks.

Inspection Frequency

The facility will be inspected and inspection visits will be completely documented:

- Once during the rainy season and once between each rainy season at a minimum.
- After every large storm (after every storm monitored or those storms with more than 0.50 inch of precipitation).

Aesthetic and Functional Maintenance

Functional maintenance is important for performance and safety reasons. Aesthetic maintenance is important for public acceptance of storm water facilities.

Aesthetic Maintenance

The following activities will be included in the aesthetic maintenance program:

- <u>Weed Control</u>. Weeds will be removed through mechanical means.

Functional Maintenance

Functional maintenance has two components:

- Preventive maintenance.
- Corrective maintenance.

Preventive Maintenance

Preventive maintenance will be done on a regular basis. Preventive maintenance activities to be instituted at a basin are:

- Trash and Debris. During each inspection and maintenance visit to the site, debris and trash removal will be conducted to reduce the potential for inlet and outlet structures and other components from becoming clogged and inoperable during storm events.
- Sediment Management. Alluvial deposits at the inlet structures may create zones of ponded water. Upon these occurrences these deposits will be graded within the basin in an effort to maintain the functionality of the BMP. Sediment grading will be accomplished by manually raking the deposits.
- Sediment Removal. Surface sediments will be removed when sediment accumulation is greater than 18-inches, or 10 percent of the basin volume, whichever is less. Vegetation removed with any surface sediment excavation activities will be replaced through reseeding.
- Mechanical Components. Regularly scheduled maintenance will be performed on valves, fence gates, locks, and access hatches in accordance with the manufacturers' recommendations. Mechanical components will be operated during each maintenance inspection to assure continued performance.
- Elimination of Mosquito Breeding Habitats. The most effective mosquito control program is one that eliminates potential breeding habitats.

Corrective Maintenance

Corrective maintenance is required on an emergency or non-routine basis to correct problems and to restore the intended operation and safe function of a basin. Corrective maintenance activities include:

- Removal of Debris and Sediment. Sediment, debris, and trash, which threaten the ability of a basin to store or convey water, will be removed immediately and properly disposed of.
- Structural Repairs. Repairs to any structural component of a basin will be made promptly (e.g., within 10 working days). Designers and contractors will conduct repairs where structural damage has occurred.
- Embankment and Slope Repairs. Damage to the embankments and slopes will be repaired quickly (e.g., within 10 working days).
- Erosion Repair. Where a reseeding program has been ineffective, or where other factors have created erosive conditions (i.e., pedestrian traffic, concentrated flow, etc.), corrective steps will be taken to prevent loss of soil and any subsequent danger to the performance of a basin. There are a number of corrective actions than can be taken. These include erosion control blankets, riprap, sodding, or reduced flow through the area. Design engineers will be consulted to address erosion problems if the solution is not evident.
- Fence Repair. Timely repair of fences (e.g., within 10 working days) will be done to maintain the security of the site.
- Elimination of Trees and Woody Vegetation. Woody vegetation will be removed from embankments.
- Elimination of Animal Burrows. Animal burrows will be filled and steps taken to remove the animals if burrowing problems continue to occur (filling and compacting). If the problem persists, vector control specialists will be consulted regarding removal steps. This consulting is

necessary as the threat of rabies in some areas may necessitate the animals being destroyed rather than relocated.

- General Facility Maintenance. In addition to the above elements of corrective maintenance, general corrective maintenance will address the overall facility and its associated components. If corrective maintenance is being done to one component, other components will be inspected to see if maintenance is needed.

Maintenance Frequency

Maintenance indicators, described above, will determine the schedule of maintenance activities to be implemented at the basin. These basins should not require a rigorous maintenance schedule, once the landscaping is established. The inspection frequency and regular preventative maintenance will indicate when corrective maintenance is necessary.

The detention basins must be inspected at least once during the rainy season and at least once between each rainy season. These basins must be maintained so that they continue to function as designed. All inspections and maintenance activities will be documented for submittal to the County of Imperial and the Regional Water Quality Control Board if requested.

ATTACHMENTS

ATTACHMENT 1

Colorado River Basin 303(d) List

2006 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SEGMENTS REQUIRING TMDLS

COLORADO RIVER BASIN REGIONAL WATER QUALITY CONTROL BOARD

USEPA APPROVAL DATE: JUNE 28, 2007

REGION	TYPE	NAME	CALWATER WATERSHED	POLLUTANT/STRESSOR	POTENTIAL SOURCES	ESTIMATED SIZE AFFECTED	PROPOSED TMDL COMPLETION
7	R	Alamo River	72310000				
				Chlorpyrifos		57 Miles	2019
					Source Unknown		
				DDT		57 Miles	2019
					Source Unknown		
				Dieldrin		57 Miles	2019
					Source Unknown		
				PCBs (Polychlorinated biphenyls)		57 Miles	2019
					Source Unknown		
				Selenium		57 Miles	2003
				Selenium originates from Upper Basin Portion of Colorado River. Elevated fish tissue levels. For 2006, selenium was moved by USEPA from the being addressed list back to the 303(d) list pending completion and USEPA approval of a TMDL.			
					Agricultural Return Flows		
				Toxaphene		57 Miles	2019
					Source Unknown		
7	R	Coachella Valley Storm Water Channel	71947000				
				Pathogens		24 Miles	2006
				This listing for pathogens only applies to a 17 mile area of the Coachella Valley Storm Water Channel from Dillion Road to the Salton Sea.			
					Source Unknown		
				Toxaphene		24 Miles	2019
				This listing for toxaphene only applies to a 2 mile area of the Coachella Valley Storm Water Channel from Lincoln Street to the Salton Sea.			
					Source Unknown		
7	R	Colorado River (Imperial Reservoir to California-Mexico Border)	72700000				
				Selenium		11 Miles	2019
					Source Unknown		

REGION	TYPE	NAME	CALWATER WATERSHED	POLLUTANT/STRESSOR	POTENTIAL SOURCES	ESTIMATED SIZE AFFECTED	PROPOSED TMDL COMPLETION
7	R	Imperial Valley Drains	72310000				
				DDT *The listing for DDT only applies to the Barbara Worth Drain, Peach Drain, and Rice Drain areas of the Imperial Valley drains.*	Source Unknown	1225 Miles	2019
				Dieldrin *The listing for dieldrin only applies to the Barbara Worth Drain and Fig Drain areas of the Imperial Valley drains.*	Source Unknown	1225 Miles	2019
				Endosulfan *The listing for endosulfan only applies to the Peach Drain area of the Imperial Valley drains.*	Source Unknown	1225 Miles	2019
				PCBs (Polychlorinated biphenyls) *The listing for PCBs only applies to the Central Drain area of the Imperial Valley drains, from Meloland Road to the outlet into the Alamo River.*	Source Unknown	1225 Miles	2019
				Selenium *Selenium originates from Upper Basin Portion of Colorado River. Elevated fish tissue levels.*	Agricultural Return Flows	1225 Miles	2019
				Toxaphene *This listing for toxaphene only applies to the Barbara Worth Drain, Peach Drain, and Rice Drain of the Imperial Valley drains.*	Source Unknown	1225 Miles	2019
7	R	New River (Imperial County)	72800000				
				1,2,4-Trimethylbenzene	Industrial Point Sources Out-of-state source	66 Miles	2006
				Chlordane	Source Unknown	66 Miles	2019
				Chloroform	Industrial Point Sources Out-of-state source	66 Miles	2006
				Chlorpyrifos	Source Unknown	66 Miles	2019

REGION	TYPE	NAME	CALWATER WATERSHED	POLLUTANT/STRESSOR	POTENTIAL SOURCES	ESTIMATED SIZE AFFECTED	PROPOSED TMDL COMPLETION
				Copper		66 Miles	2019
				This listing was made by USEPA for 2006.			
					Source Unknown		
				DDT		66 Miles	2019
					Source Unknown		
				Diazinon		66 Miles	2019
					Source Unknown		
				Dieldrin		66 Miles	2019
					Source Unknown		
				Mercury		66 Miles	2019
					Source Unknown		
				meta-para xylenes		66 Miles	2006
					Industrial Point Sources		
					Out-of-state source		
				Nutrients		66 Miles	2006
				Regional Board proposes to establish TMDL in cooperation with U.S. EPA and Mexico.			
					Major Municipal Point Source-dry and/or wet weather discharge		
					Agricultural Return Flows		
					Out-of-state source		
				Organic Enrichment/Low Dissolved Oxygen		66 Miles	2006
					Wastewater		
					Inappropriate Waste Disposal/Wildcat Dumping		
					Out-of-state source		
					Unknown point source		
				o-Xylenes		66 Miles	2006
					Industrial Point Sources		
					Out-of-state source		

REGION	TYPE	NAME	CALWATER WATERSHED	POLLUTANT/STRESSOR	POTENTIAL SOURCES	ESTIMATED SIZE AFFECTED	PROPOSED TMDL COMPLETION
				PCBs (Polychlorinated biphenyls)	Source Unknown	66 Miles	2019
				p-Cymene	Industrial Point Sources Out-of-state source	66 Miles	2006
				p-Dichlorobenzene/DCB	Industrial Point Sources Out-of-state source	66 Miles	2006
				Pesticides	Agricultural Return Flows Out-of-state source	66 Miles	2019
				Selenium	Source Unknown	66 Miles	2019
				Toluene	Industrial Point Sources Out-of-state source	66 Miles	2006
				Toxaphene	Source Unknown	66 Miles	2019
				Toxicity	Source Unknown	66 Miles	2019
				Trash	Out-of-state source	66 Miles	2006
7	R	Palo Verde Outfall Drain and Lagoon	71540000	DDT	Source Unknown	19 Miles	2019

REGION	TYPE	NAME	CALWATER WATERSHED	POLLUTANT/STRESSOR	POTENTIAL SOURCES	ESTIMATED SIZE AFFECTED	PROPOSED TMDL COMPLETION
				Pathogens		19 Miles	2019
				This listing was made by USEPA for 2006.			
					Source Unknown		
7	S	Salton Sea	72800000				
				Nutrients		233340 Acres	2006
					Major Industrial Point Source		
					Agricultural Return Flows		
					Out-of-state source		
				Salinity		233340 Acres	2019
				TMDL development will not be effective in addressing this problem, which will require an engineering solution with federal, local, and state cooperation.			
					Agricultural Return Flows		
					Out-of-state source		
					Point Source		
				Selenium		233340 Acres	2019
					Agricultural Return Flows		

REGION	TYPE	NAME	CALWATER WATERSHED	POLLUTANT/STRESSOR	POTENTIAL SOURCES	ESTIMATED SIZE AFFECTED	PROPOSED TMDL COMPLETION

ABBREVIATIONS

REGIONAL WATER QUALITY CONTROL BOARDS

1 North Coast
2 San Francisco Bay
3 Central Coast
4 Los Angeles
5 Central Valley
6 Lahontan
7 Colorado River Basin
8 Santa Ana
9 San Diego

WATER BODY TYPE

B = Bays and Harbors
C = Coastal Shorelines/Beaches
E = Estuaries
L = Lakes/Reserviors
R = Rivers and Streams
S = Saline Lakes
T = Wetlands, Tidal
W= Wetlands, Freshwater

CALWATER WATERSHED

"Calwater Watershed" is the State Water Resources Control Board hydrological subunit area or an even smaller area delineation.

GROUP A PESTICIDES OR CHEM A

aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (including lindane), endosulfan, and toxaphene

ATTACHMENT 2

Site Map (BMP Location Map)

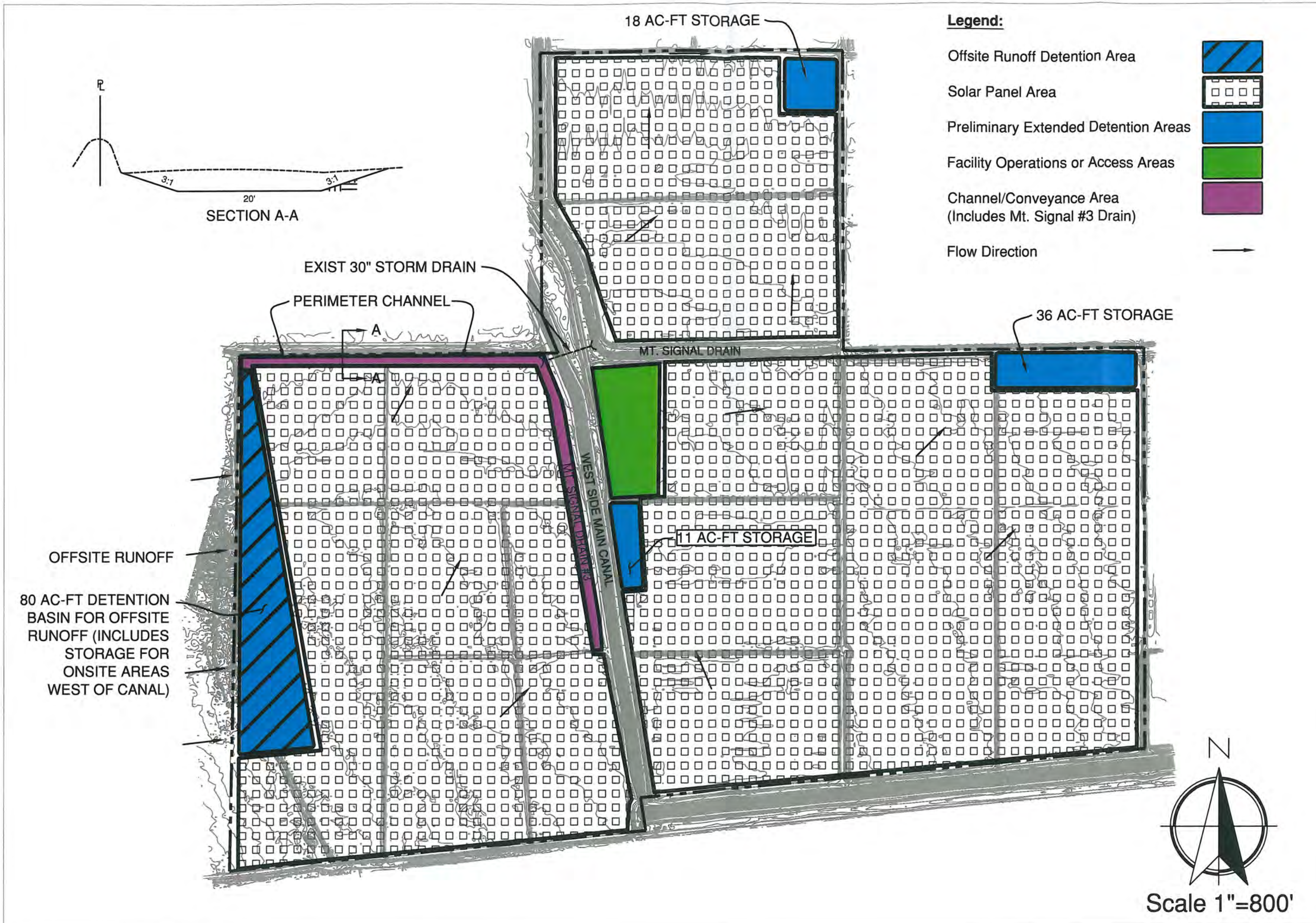

Figure 2: Site Map (BMP Location Map)

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ATTACHMENT 3

BMP Datasheets

Design Considerations

- Tributary Area
- Area Required
- Hydraulic Head

Description

Dry extended detention ponds (a.k.a. dry ponds, extended detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to detain the stormwater runoff from a water quality design storm for some minimum time (e.g., 48 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool. They can also be used to provide flood control by including additional flood detention storage.

California Experience

Caltrans constructed and monitored 5 extended detention basins in southern California with design drain times of 72 hours. Four of the basins were earthen, less costly and had substantially better load reduction because of infiltration that occurred, than the concrete basin. The Caltrans study reaffirmed the flexibility and performance of this conventional technology. The small headloss and few siting constraints suggest that these devices are one of the most applicable technologies for stormwater treatment.

Advantages

- Due to the simplicity of design, extended detention basins are relatively easy and inexpensive to construct and operate.
- Extended detention basins can provide substantial capture of sediment and the toxics fraction associated with particulates.
- Widespread application with sufficient capture volume can provide significant control of channel erosion and enlargement caused by changes to flow frequency

Targeted Constituents

☑	Sediment	▲
☑	Nutrients	●
☑	Trash	■
☑	Metals	▲
☑	Bacteria	▲
☑	Oil and Grease	▲
☑	Organics	▲

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

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relationships resulting from the increase of impervious cover in a watershed.

Limitations

- Limitation of the diameter of the orifice may not allow use of extended detention in watersheds of less than 5 acres (would require an orifice with a diameter of less than 0.5 inches that would be prone to clogging).

- Dry extended detention ponds have only moderate pollutant removal when compared to some other structural stormwater practices, and they are relatively ineffective at removing soluble pollutants.

- Although wet ponds can increase property values, dry ponds can actually detract from the value of a home due to the adverse aesthetics of dry, bare areas and inlet and outlet structures.

Design and Sizing Guidelines

- Capture volume determined by local requirements or sized to treat 85% of the annual runoff volume.

- Outlet designed to discharge the capture volume over a period of hours.

- Length to width ratio of at least 1.5:1 where feasible.

- Basin depths optimally range from 2 to 5 feet.

- Include energy dissipation in the inlet design to reduce resuspension of accumulated sediment.

- A maintenance ramp and perimeter access should be included in the design to facilitate access to the basin for maintenance activities and for vector surveillance and control.

- Use a draw down time of 48 hours in most areas of California. Draw down times in excess of 48 hours may result in vector breeding, and should be used only after coordination with local vector control authorities. Draw down times of less than 48 hours should be limited to BMP drainage areas with coarse soils that readily settle and to watersheds where warming may be determined to downstream fisheries.

Construction/Inspection Considerations

- Inspect facility after first large to storm to determine whether the desired residence time has been achieved.

- When constructed with small tributary area, orifice sizing is critical and inspection should verify that flow through additional openings such as bolt holes does not occur.

Performance

One objective of stormwater management practices can be to reduce the flood hazard associated with large storm events by reducing the peak flow associated with these storms. Dry extended detention basins can easily be designed for flood control, and this is actually the primary purpose of most detention ponds.

Dry extended detention basins provide moderate pollutant removal, provided that the recommended design features are incorporated. Although they can be effective at removing some pollutants through settling, they are less effective at removing soluble pollutants because of the absence of a permanent pool. Several studies are available on the effectiveness of dry extended detention ponds including one recently concluded by Caltrans (2002).

The load reduction is greater than the concentration reduction because of the substantial infiltration that occurs. Although the infiltration of stormwater is clearly beneficial to surface receiving waters, there is the potential for groundwater contamination. Previous research on the effects of incidental infiltration on groundwater quality indicated that the risk of contamination is minimal.

There were substantial differences in the amount of infiltration that were observed in the earthen basins during the Caltrans study. On average, approximately 40 percent of the runoff entering the unlined basins infiltrated and was not discharged. The percentage ranged from a high of about 60 percent to a low of only about 8 percent for the different facilities. Climatic conditions and local water table elevation are likely the principal causes of this difference. The least infiltration occurred at a site located on the coast where humidity is higher and the basin invert is within a few meters of sea level. Conversely, the most infiltration occurred at a facility located well inland in Los Angeles County where the climate is much warmer and the humidity is less, resulting in lower soil moisture content in the basin floor at the beginning of storms.

Vegetated detention basins appear to have greater pollutant removal than concrete basins. In the Caltrans study, the concrete basin exported sediment and associated pollutants during a number of storms. Export was not as common in the earthen basins, where the vegetation appeared to help stabilize the retained sediment.

Siting Criteria

Dry extended detention ponds are among the most widely applicable stormwater management practices and are especially useful in retrofit situations where their low hydraulic head requirements allow them to be sited within the constraints of the existing storm drain system. In addition, many communities have detention basins designed for flood control. It is possible to modify these facilities to incorporate features that provide water quality treatment and/or channel protection. Although dry extended detention ponds can be applied rather broadly, designers need to ensure that they are feasible at the site in question. This section provides basic guidelines for siting dry extended detention ponds.

In general, dry extended detention ponds should be used on sites with a minimum area of 5 acres. With this size catchment area, the orifice size can be on the order of 0.5 inches. On smaller sites, it can be challenging to provide channel or water quality control because the orifice diameter at the outlet needed to control relatively small storms becomes very small and thus prone to clogging. In addition, it is generally more cost-effective to control larger drainage areas due to the economies of scale.

Extended detention basins can be used with almost all soils and geology, with minor design adjustments for regions of rapidly percolating soils such as sand. In these areas, extended detention ponds may need an impermeable liner to prevent ground water contamination.

The base of the extended detention facility should not intersect the water table. A permanently wet bottom may become a mosquito breeding ground. Research in Southwest Florida (Santana et al., 1994) demonstrated that intermittently flooded systems, such as dry extended detention ponds, produce more mosquitoes than other pond systems, particularly when the facilities remained wet for more than 3 days following heavy rainfall.

A study in Prince George's County, Maryland, found that stormwater management practices can increase stream temperatures (Galli, 1990). Overall, dry extended detention ponds increased temperature by about 5°F. In cold water streams, dry ponds should be designed to detain stormwater for a relatively short time (i.e., 24 hours) to minimize the amount of warming that occurs in the basin.

Additional Design Guidelines

In order to enhance the effectiveness of extended detention basins, the dimensions of the basin must be sized appropriately. Merely providing the required storage volume will not ensure maximum constituent removal. By effectively configuring the basin, the designer will create a long flow path, promote the establishment of low velocities, and avoid having stagnant areas of the basin. To promote settling and to attain an appealing environment, the design of the basin should consider the length to width ratio, cross-sectional areas, basin slopes and pond configuration, and aesthetics (Young et al., 1996).

Energy dissipation structures should be included for the basin inlet to prevent resuspension of accumulated sediment. The use of stilling basins for this purpose should be avoided because the standing water provides a breeding area for mosquitoes.

Extended detention facilities should be sized to completely capture the water quality volume. A micropool is often recommended for inclusion in the design and one is shown in the schematic diagram. These small permanent pools greatly increase the potential for mosquito breeding and complicate maintenance activities; consequently, they are not recommended for use in California.

A large aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W) where feasible. Basin depths optimally range from 2 to 5 feet.

The facility's drawdown time should be regulated by an orifice or weir. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes. The outlet design implemented by Caltrans in the facilities constructed in San Diego County used an outlet riser with orifices

Figure 1
Example of Extended Detention Outlet Structure

sized to discharge the water quality volume, and the riser overflow height was set to the design storm elevation. A stainless steel screen was placed around the outlet riser to ensure that the orifices would not become clogged with debris. Sites either used a separate riser or broad crested weir for overflow of runoff for the 25 and greater year storms. A picture of a typical outlet is presented in Figure 1.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure can be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed.

Summary of Design Recommendations

(1) Facility Sizing - The required water quality volume is determined by local regulations or the basin should be sized to capture and treat 85% of the annual runoff volume. See Section 5.5.1 of the handbook for a discussion of volume-based design.

Basin Configuration – A high aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W). The flowpath length is defined as the distance from the inlet to the outlet as measured at the surface. The width is defined as the mean width of the basin. Basin depths optimally range from 2 to 5 feet. The basin may include a sediment forebay to provide the opportunity for larger particles to settle out.

A micropool should not be incorporated in the design because of vector concerns. For online facilities, the principal and emergency spillways must be sized to provide 1.0 foot of freeboard during the 25-year event and to safely pass the flow from 100-year storm.

(2) Pond Side Slopes - Side slopes of the pond should be 3:1 (H:V) or flatter for grass stabilized slopes. Slopes steeper than 3:1 (H:V) must be stabilized with an appropriate slope stabilization practice.

(3) Basin Lining – Basins must be constructed to prevent possible contamination of groundwater below the facility.

(4) Basin Inlet – Energy dissipation is required at the basin inlet to reduce resuspension of accumulated sediment and to reduce the tendency for short-circuiting.

(5) Outflow Structure - The facility's drawdown time should be regulated by a gate valve or orifice plate. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure should be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed. This same valve also can be used to regulate the rate of discharge from the basin.

The discharge through a control orifice is calculated from:

$$Q = CA(2gH\text{-}H_o)^{0.5}$$

where:
Q = discharge (ft^3/s)
C = orifice coefficient
A = area of the orifice (ft^2)
g = gravitational constant (32.2)
H = water surface elevation (ft)
H_o= orifice elevation (ft)

Recommended values for C are 0.66 for thin materials and 0.80 when the material is thicker than the orifice diameter. This equation can be implemented in spreadsheet form with the pond stage/volume relationship to calculate drain time. To do this, use the initial height of the water above the orifice for the water quality volume. Calculate the discharge and assume that it remains constant for approximately 10 minutes. Based on that discharge, estimate the total discharge during that interval and the new elevation based on the stage volume relationship. Continue to iterate until H is approximately equal to H_o. When using multiple orifices the discharge from each is summed.

(6) Splitter Box - When the pond is designed as an offline facility, a splitter structure is used to isolate the water quality volume. The splitter box, or other flow diverting approach, should be designed to convey the 25-year storm event while providing at least 1.0 foot of freeboard along pond side slopes.

(7) Erosion Protection at the Outfall - For online facilities, special consideration should be given to the facility's outfall location. Flared pipe end sections that discharge at or near the stream invert are preferred. The channel immediately below the pond outfall should be modified to conform to natural dimensions, and lined with large stone riprap placed over filter cloth. Energy dissipation may be required to reduce flow velocities from the primary spillway to non-erosive velocities.

(8) Safety Considerations - Safety is provided either by fencing of the facility or by managing the contours of the pond to eliminate dropoffs and other hazards. Earthen side slopes should not exceed 3:1 (H:V) and should terminate on a flat safety bench area. Landscaping can be used to impede access to the facility. The primary spillway opening must not permit access by small children. Outfall pipes above 48 inches in diameter should be fenced.

Maintenance

Routine maintenance activity is often thought to consist mostly of sediment and trash and debris removal; however, these activities often constitute only a small fraction of the maintenance hours. During a recent study by Caltrans, 72 hours of maintenance was performed annually, but only a little over 7 hours was spent on sediment and trash removal. The largest recurring activity was vegetation management, routine mowing. The largest absolute number of hours was associated with vector control because of mosquito breeding that occurred in the stilling basins (example of standing water to be avoided) installed as energy dissipaters. In most cases, basic housekeeping practices such as removal of debris accumulations and vegetation management to ensure that the basin dewaters completely in 48-72 hours is sufficient to prevent creating mosquito and other vector habitats.

Consequently, maintenance costs should be estimated based primarily on the mowing frequency and the time required. Mowing should be done at least annually to avoid establishment of woody vegetation, but may need to be performed much more frequently if aesthetics are an important consideration.

Typical activities and frequencies include:

- Schedule semiannual inspection for the beginning and end of the wet season for standing water, slope stability, sediment accumulation, trash and debris, and presence of burrows.
- Remove accumulated trash and debris in the basin and around the riser pipe during the semiannual inspections. The frequency of this activity may be altered to meet specific site conditions.
- Trim vegetation at the beginning and end of the wet season and inspect monthly to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and regrade about every 10 years or when the accumulated sediment volume exceeds 10 percent of the basin volume. Inspect the basin each year for accumulated sediment volume.

Cost

Construction Cost

The construction costs associated with extended detention basins vary considerably. One recent study evaluated the cost of all pond systems (Brown and Schueler, 1997). Adjusting for inflation, the cost of dry extended detention ponds can be estimated with the equation:

$$C = 12.4V^{0.760}$$

where: C = Construction, design, and permitting cost, and
V = Volume (ft^3).

Using this equation, typical construction costs are:

$ 41,600 for a 1 acre-foot pond

$ 239,000 for a 10 acre-foot pond

$ 1,380,000 for a 100 acre-foot pond

Interestingly, these costs are generally slightly higher than the predicted cost of wet ponds (according to Brown and Schueler, 1997) on a cost per total volume basis, which highlights the difficulty of developing reasonably accurate construction estimates. In addition, a typical facility constructed by Caltrans cost about $160,000 with a capture volume of only 0.3 ac-ft.

An economic concern associated with dry ponds is that they might detract slightly from the value of adjacent properties. One study found that dry ponds can actually detract from the perceived value of homes adjacent to a dry pond by between 3 and 10 percent (Emmerling-Dinovo, 1995).

Maintenance Cost

For ponds, the annual cost of routine maintenance is typically estimated at about 3 to 5 percent of the construction cost (EPA website). Alternatively, a community can estimate the cost of the maintenance activities outlined in the maintenance section. Table 1 presents the maintenance costs estimated by Caltrans based on their experience with five basins located in southern California. Again, it should be emphasized that the vast majority of hours are related to vegetation management (mowing).

Table 1 Estimated Average Annual Maintenance Effort

Activity	Labor Hours	Equipment & Material ($)	Cost
Inspections	4	7	183
Maintenance	49	126	2282
Vector Control	0	0	0
Administration	3	0	132
Materials	-	535	535
Total	**56**	**$668**	**$3,132**

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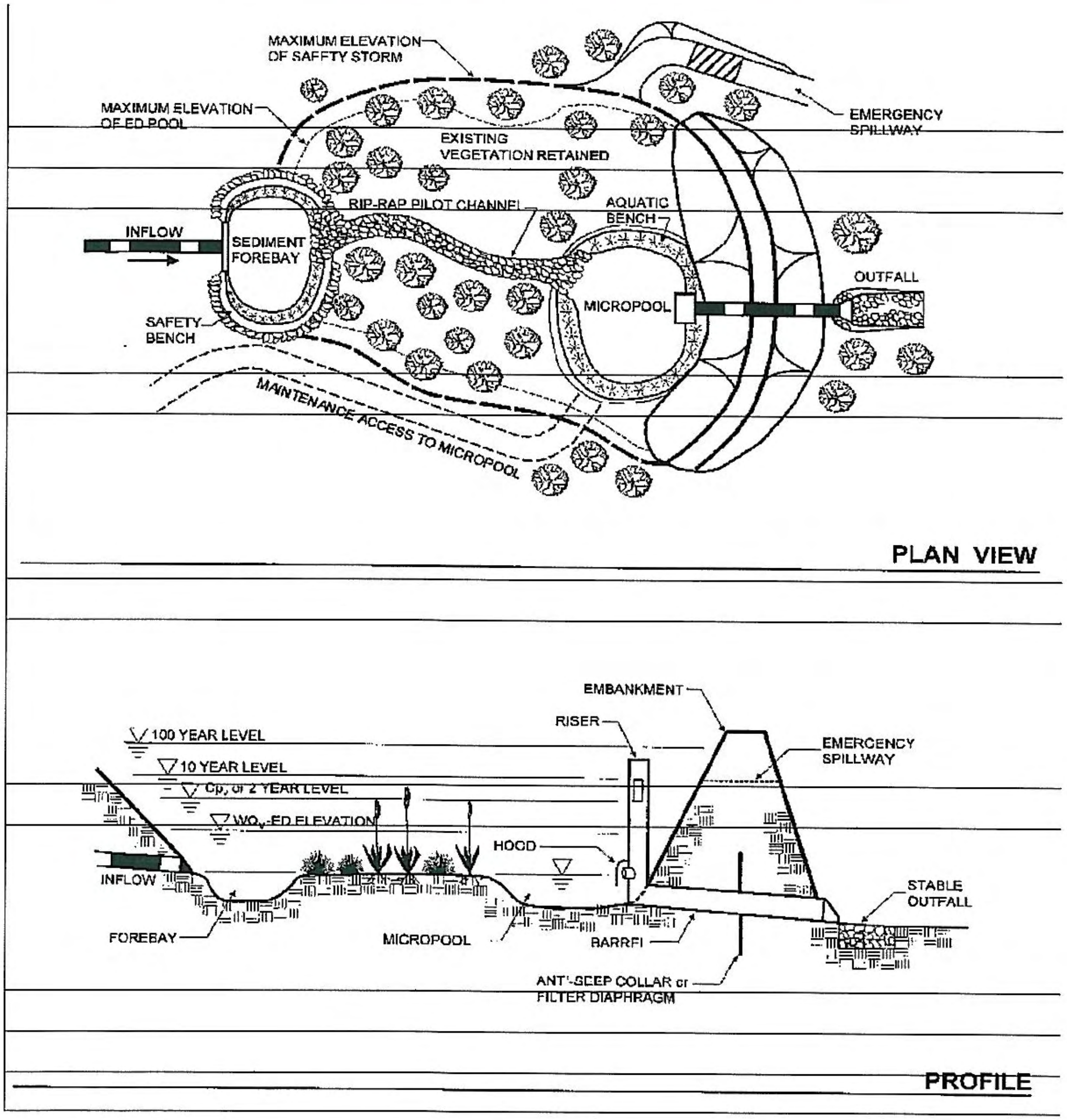

Schematic of an Extended Detention Basin (MDE, 2000)